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Title of the Invention: Separator for Capacitor and Capacitor  
Using the Same

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[CLAIMS]

1. A separator for capacitors, comprising a hydrophilized porous fluororesin film having filled into the micropores thereof a water-soluble polymer.

2. A capacitor comprising a cathode, an anode and a separator for capacitors disposed therebetween, said separator comprising a hydrophilized porous fluororesin film having filled into the micropores thereof a water-soluble polymer.

[DETAILED DESCRIPTION OF THE INVENTION]

[Field of Utilization in Industry]

The present invention relates to a separator for capacitors and a capacitor using the separator.

[Prior Art]

Manila paper has been conventionally used as the separator for capacitors such as an electrolytic capacitor and an electric double-layer capacitor.

The electrolytic capacitor using Manila paper as the separator has high capacity and is cheap and therefore, it is being widely used as the parts of an electronic equipment. The electric double-layer capacitor using Manila paper as the separator is being used as the parts of a backup power.

[Problems to be Solved by the Invention]

The capacitors are preferred to have a low equivalent series resistance (hereinafter referred to as "ESR"). By having a low ESR, the electrolytic capacitor can be downsized and the electric double-layer capacitor can be reduced in the

backup time.

For reducing the ESR of these capacitors, the Manila paper separator is treated to have a high porosity. However, the Manila paper increased in the porosity is liable to decrease in the mechanical strength and therefore, satisfactory reduction in the ESR has not yet been achieved.

The object of the present invention is, accordingly, to provide a separator capable of achieving reduction in the ESR of a capacitor into which the separator is loaded.

#### [Means to Solve the Problems]

The separator for capacitors according to the present invention comprises a hydrophilized porous fluororesin film having filled into the micropores thereof a water-soluble polymer.

The porous film comprises a fluororesin such as polytetrafluoroethylene (PTFE), polyvinylidene fluoride (PVdF), tetrafluoroethylene-perfluoroalkyl vinyl ether copolymer (PFA), tetrafluoroethylene-hexafluoropropylene copolymer (FEP), ethylene-tetrafluoroethylene copolymer (ETFE) or polychlorotrifluoroethylene (PCTFE). In view of the chemical resistance and heat resistance, PTFE is preferred. The thickness, pore size and porosity of the porous fluororesin film may be appropriately selected, however, in general, the thickness is 50  $\mu\text{m}$  or less, the pore size is from 0.01 to 20  $\mu\text{m}$  and the porosity is from 60 to 95%.

In the present invention, the porous fluororesin film is hydrophilized before use. The hydrophilizing treatment of the porous fluororesin film is not particularly limited and conventionally known methods may be used. Specific examples of the method for hydrophilizing the porous fluororesin film include treatment with an alcohol, coating with a substance having affinity for polar organic solvents, sputter-etching, and treatment with a surface active agent. Hydrophilizing treatment with a surface active agent may be performed, for example, by the method of immersing a porous fluororesin film in a solution containing a fluorine-base surface active agent

dissolved in an appropriate solvent, pulling it up and then removing the solvent.

In the present invention, the hydrophilized porous fluororesin film is then subjected to filling of a water-soluble polymer into micropores thereof. The impregnation of a water-soluble polymer into micropores of the porous film may be performed, for example, by the method of immersing the porous fluororesin film in an aqueous polymer solution, pulling it up and removing water. Specific examples of the water-soluble polymer include starch, gelatin, methyl cellulose, ethyl cellulose, hydroxymethyl cellulose, hydroxyethyl cellulose, polyvinyl alcohol and polyvinyl methyl ether.

The separator obtained by filling a water-soluble polymer into micropores of the hydrophilized porous fluororesin film is disposed between the cathode and the anode similarly to the conventional Manila paper separator to produce an electrolytic capacitor or an electric double-layer capacitor. In fabricating the capacitor, the separator is impregnated with an electrolytic solution.

In the case of obtaining an electrolytic capacitor, the electrolytic solution used may be a solution prepared by dissolving an electrolyte such as adipate or phthalate in a solvent such as ethylene glycol,  $\gamma$ -butyrolactone or dimethylformamide, the cathode used may be a metal foil having film-forming ability, such as aluminum or tantalum, and subjected to formation of a dielectric thin film on the surface thereof, and the anode used may be an anode-forming metal foil.

In the case of obtaining an electric double-layer capacitor, the electrolytic solution used may be an aqueous sulfuric acid solution, an aqueous potassium hydroxide solution or a solution prepared by dissolving an electrolyte such as perchlorate in an organic solvent such as  $\gamma$ -butyrolactone, dimethylformamide, dimethyl sulfoxide or propylene carbonate, and the electrode used may be an activated carbon fiber cloth or an activated carbon fiber

cloth having formed on one surface thereof an electrically conductive layer.

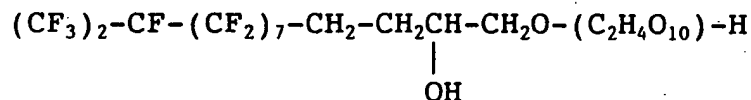
[Examples]

The present invention is described in greater detail below by referring to the Examples.

Example

A solution was prepared by dissolving a fluorine-base surface active agent in ethyl alcohol (surface active agent concentration: 1 wt%). The surface active agent used is DS403 produced by Daikin Kogyo KK and has a chemical structure shown below in Chemical 1.

[Chemical 1]



A PTFE-made porous film having a thickness of 15  $\mu\text{m}$ , a pore size of 15  $\mu\text{m}$  and a porosity of 90% was immersed for 1 minute in the surface active agent solution obtained above, pulled up and air dried to remove ethyl alcohol by distillation. Then, a hydrophilized porous PTFE film was obtained.

This hydrophilized porous PTFE film was then immersed in an aqueous methyl cellulose solution (methyl cellulose concentration: 10 wt%) for 1 minute, pulled up and then heated at 40°C for 10 minutes to remove water by distillation. Thus, a separator was obtained.

Two sheets of aluminum foil were used as the anode and the cathode, and the separator obtained above was interposed these electrodes to fabricate an electrolytic capacitor. The separator had been impregnated with an electrolytic solution prepared by dissolving a quaternary ammonium phthalate (electrolyte) in  $\gamma$ -butyrolactone. The electrolytic capacitor fabricated had an ESR of 83 m $\Omega$ .

Comparative Example

An electrolytic capacitor was fabricated in the same

manner as in the Example except for using Manila paper having a thickness of 37  $\mu\text{m}$  and a density of 0.332  $\text{g/cm}^3$  as the separator. The capacitor obtained had an ESR of 210  $\text{m}\Omega$ .

[Effects of the Invention]

According to the present invention, the porous fluorine resin is hydrophilized and a water-soluble polymer is filled into the micropores thereof, therefore, the separator is advantageous in that the capacitor having loaded therein the separator is low in the ESR.